

communication with a destination **511** via valves **504** and **506** respectively. As noted above, the destination **511** may be a human subject, a reservoir, a container, such as a heating bag, or another, perhaps larger, pump chamber.

[0048] In accordance with one embodiment, the goal is to separately track the volumes moved from each fluid source **501** and **502** and to ensure that the difference between the fluid delivered from each of the two fluid sources never varies by more than half the volume of a pump chamber. This is achieved by performing in-phase pumping such that both pump chambers **507** and **510** fill and deliver in sync. For example, if each pump chamber holds 15 mL, and it is determined that one pump chamber, for example pump chamber **507**, has delivered at least 7.5 mL more fluid to the destination **511** than the other pump chamber **510**, then fluid delivery from pump chamber **507** will be suspended while pump chamber **510** performs a catch-up stroke. Such a determination is made by measuring the fluid volumes of each pump chamber **507** and **510** for each pumping stroke via volume measurement systems **508** and **509** respectively. (It should be noted that while each pump chamber **507** and **510** may have a capacity of 15 mL, somewhat less than 15 mL of fluid may be delivered to and by each pump chamber during any single pumping stroke.)

[0049] When the target volume (the volume of fluid intended to be delivered to the destination) has been delivered to the destination **511**, the pump chamber, perhaps pump chamber **510**, that has delivered the most fluid to the destination **511** will stop pumping. The pump chamber which has delivered the least amount of fluid, in this case pump chamber **507**, will then switch to a “targeting mode” in which a maximum of 3 mL of fluid is delivered to the destination **511** per pump chamber stroke. This targeting mode insures that a 1:1 ratio (or other desired ratio) between fluid delivered to the destination **511** from the first fluid source **501** and fluid delivered to the destination **511** from the second fluid source **502** is achieved to within approximately plus 2 mL or minus 1 mL.

[0050] While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification. This application is intended to cover any variation, uses, or adaptations of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains.

1. (canceled)

2. A method for operating a fluid control module of a pumping system comprising a controller to control operation of a pump cassette to deliver a target volume of a desired mixture ratio of a first medical fluid and a second medical fluid, the method comprising:

- a. pumping, under control of the fluid control module, the first medical fluid in a first incremental volume using a first pump chamber of the pump cassette, wherein the first incremental volume is less than the target volume;
- b. pumping, under control of the fluid control module, the second medical fluid in the first incremental volume using a second pump chamber of the pump cassette;
- c. receiving data associated with the first and second pump chambers with the controller indicative of a volume of the first medical fluid pumped to the source by the first pump chamber and a volume of the second medical fluid pumped to the source by the second pump chamber;

d. repeating steps (a) and (b) until in step (c), a volume of the first medical fluid pumped to the source by the first pump chamber meets or exceeds a first predetermined volume based on the desired mixture ratio, or a volume of the second medical fluid pumped to the source by the second pump chamber meets or exceeds a second predetermined volume based on the desired mixture ratio;

e. determining with the controller after step (d), if either the volume of the first medical fluid pumped to the source by the first pump chamber is less than the first predetermined volume, or the volume of the second medical fluid pumped to the source by the second pump chamber is less than the second predetermined volume, and, if so, under control of the fluid control module, repeating either step (a), if the volume of the first medical fluid pumped to the source is less than the first predetermined volume, or step (b), if the volume of the second medical fluid pumped to the source is less than the second predetermined volume, until both the volume of the first medical fluid pumped to the source by the first pump chamber meets or exceeds the first predetermined volume, and the volume of the second medical fluid pumped to the source by the second pump chamber meets or exceeds the second predetermined volume; and

f. repeating steps (a) through (e) until the target volume has been delivered.

3. The method according to claim 2, wherein the first predetermined volume of the first medical fluid plus the second predetermined volume of the second medical fluid equals the target volume minus a finish volume.

4. The method according to claim 2, wherein the data received by the controller in step c comprises pressure data associated with the first and second pump chambers.

5. A method for operating a fluid control module of a pumping system comprising a controller to control operation of a pump cassette to deliver a target volume of a desired mixture ratio of a first medical fluid and a second medical fluid, the method comprising:

- a. pumping, under control of the fluid control module, the first medical fluid in a first incremental volume using a first pump chamber of the pump cassette, wherein the first incremental volume is less than the target volume;
- b. pumping, under control of the fluid control module, the second medical fluid in the first incremental volume using a second pump chamber of the pump cassette;
- c. receiving data associated with the first and second pump chambers with the controller indicative of a volume of the first medical fluid pumped to the source by the first pump chamber and a volume of the second medical fluid pumped to the source by the second pump chamber;
- d. repeating steps (a) and (b) until in step (c), the volume of the first medical fluid pumped to the source by the first pump chamber meets or exceeds a first predetermined volume based on the desired mixture ratio, or the volume of the second medical fluid pumped to the source by the second pump chamber meets or exceeds a second predetermined volume based on the desired mixture ratio;
- e. determining with the controller after step (d), if either the volume of the first medical fluid pumped to the source by the first pump chamber is less than the first